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Indian Standard

GEOMETRICAL PRODUCT SPECIFICATIONS (GPS) — SURFACE TEXTURE : PROFILE METHOD — METROLOGICAL CHARACTERISTICS OF PHASE CORRECT FILTERS

ICS 17.040.20

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

August 2003 **Price Group 4**

Engineering Metrology Sectional Committee, BP 25

NATIONAL FOREWORD

This Indian Standard which is identical with ISO 11562 : 1996 'Geometrical Product Specifications (GPS) — Surface texture : Profile method — Metrological characteristics of phase correct filters' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendations of the Engineering Metrology Sectional Committee and approval of the Basic and Production Engineering Division Council.

This standard specifies the metrological characteristics of phase correct filters for the measurement of surface profiles. In particular, it specifies how to separate the long and short wave content of a surface profile.

For digital instruments, the appropriate filter for surface profile information is phase correct filter. The chosen weighting function, for the phase correct filter, is Gaussian with a 50 percent transmission at the cut-off wavelength. This provides a transmission characteristic with a relatively sharp cut-off.

It is of importance that the transmission for the cut-off wavelength is 50 percent since the short wave and long wave portions of the surface profile are separated and can be recombined without altering the surface profile.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appears, referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

Technical Corrigendum 1 to the above International Standard has been incorporated.

Indian Standard

GEOMETRICAL PRODUCT SPECIFICATIONS (GPS) — SURFACE TEXTURE : PROFILE METHOD — METROLOGICAL CHARACTERISTICS OF PHASE CORRECT FILTERS

1 Scope

This International Standard specifies the metrological characteristics of phase correct filters for the measurement of surface pofiles.

In particular it specifies how to separate the long and short wave content of a surface profile.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 profile filter: Filter which serapates profiles into longwave and shortwave components.

2.1.1 phase correct profile filter: Profile filter which does not cause phase shifts which lead to asymmetrical profile distortions.

2.2 phase correct filter mean line (mean line): Long wave profile component which is determined for any point of the profile by a weighted mean value derived from adjacent points.

2.3 transmission characteristic of a filter: Characteristic which indicates the amount by which the amplitude of a sinusoidal profile is attenuated as a function of its wavelength.

2.4 weighting function: Function for calculating the mean line which indicates for each point the weight attached by the profile in the neighbourhood of that point.

NOTE — The transmission characteristic of the mean line is the Fourier transformation of the weighting function.

2.5 cut-off wavelength of the phase correct filter: Wavelength of a sinusoidal profile of which 50 % of the amplitude is transmitted by the profile filter.

NOTE — Profile filters are identified by their cut-off wavelength value.

2.6 transmission band for profiles: Band of sinusoidal profile wavelengths which are transmitted at more than 50 % when two phase correct filters of different cut-off wavelengths are applied to the profile.

NOTE — The profile filter with the shorter cut-off wavelength retains the long wave profile component and the profile filter with the longer cut-off wavelength retains the short wave profile component.

2.7 cut-off ratio: Ratio of the long wavelength characteristic cut-off to the short wavelength characteristic cut-off of a given transmission band.

3 Characteristics of phase correct profile filters

3.1 Weighting function for the phase correct profile filter

The weighting function of the phase correct filter (see figure 1) corresponds to the equation of the Gaussian density function. With the cut-off wavelength λco (where co = cut-off), the equation is as follows:

$$s(x) = \frac{1}{\alpha \lambda co} e^{-\pi \left(\frac{x}{\alpha \lambda co} \right)^2} \quad \ldots (1)$$

where

x is the position in relation to the centre of the weighting function;

λco is the cut-off wavelength of the profile filter;

$$\alpha = \sqrt{\frac{\ln 2}{\pi}} = 0{,}469\ 7 \quad \ldots (2)$$

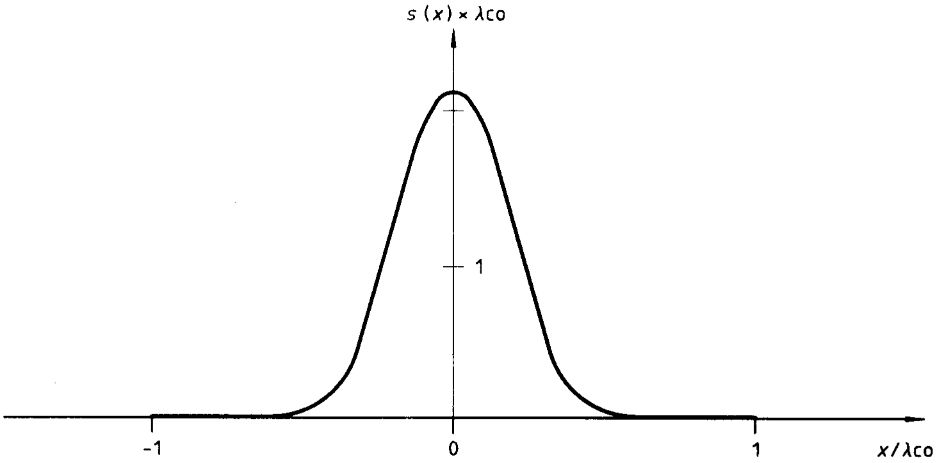


Figure 1 — Weighting function of the profile filter

3.2 Transmission characteristic

3.2.1 Transmission characteristic of the long wave profile component (mean line)

The filter characteristic (see figure 2) is determined from the weighting function by means of the Fourier transformation. The filter characteristic for the mean line corresponds to the following equation:

$$\frac{a_1}{a_0} = e^{-\pi\left(\frac{\alpha\,\lambda co}{\lambda}\right)^2} \qquad \ldots (3)$$

where

a_0 is the amplitude of sine wave roughness profile before filtering;

a_1 is the amplitude of this sine profile in the mean line;

λco is the limiting wavelength of the profile filter;

λ is the wavelength of the sine profile.

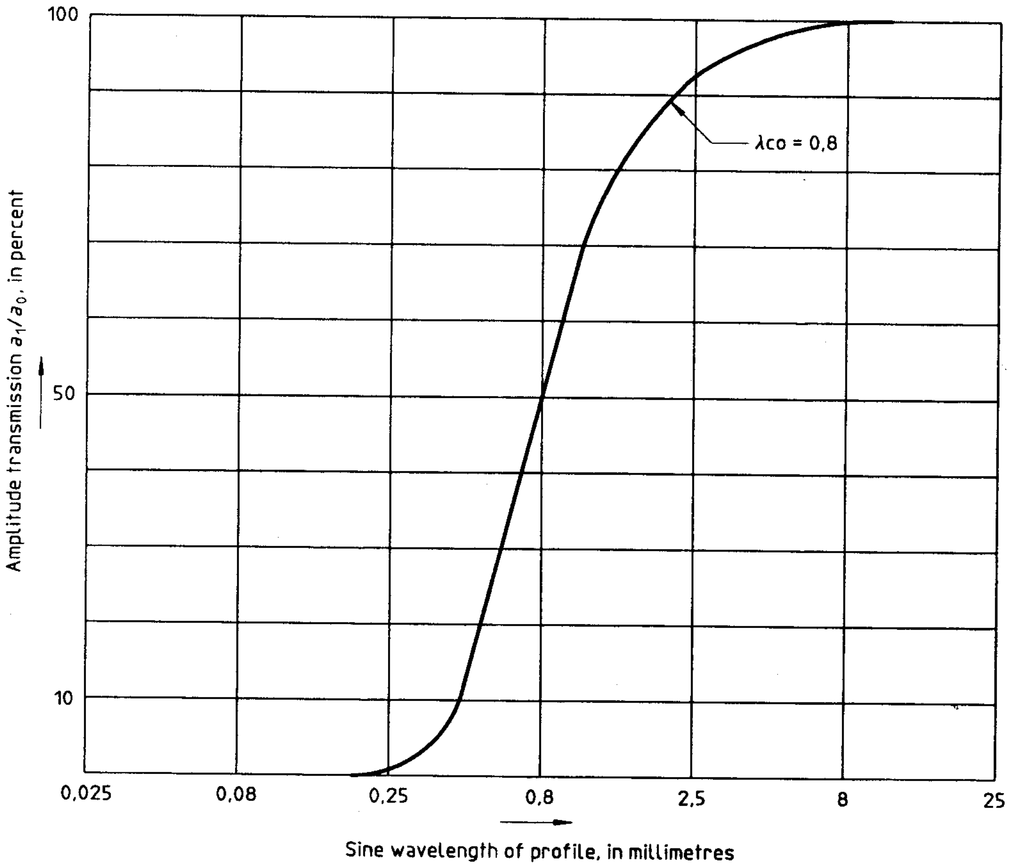


Figure 2 — Transmission characteristic of the long wave profile component

3.2.2 Transmission characteristic of the short wave profile component

The transmission characteristic of the short wave profile component is complementary to the transmission characteristic of the long wave profile component.

The short wave profile component is the difference between the surface profile and the long wave profile component. The equation as a function of the limiting wavelength λco is:

$$\frac{a_2}{a_0} = 1 - e^{-\pi\left(\frac{\alpha \lambda co}{\lambda}\right)^2} \quad ; \quad \frac{a_2}{a_0} = 1 - \frac{a_1}{a_0} \qquad \ldots (4)$$

where a_2 is the amplitude of the sine wave roughness profile.

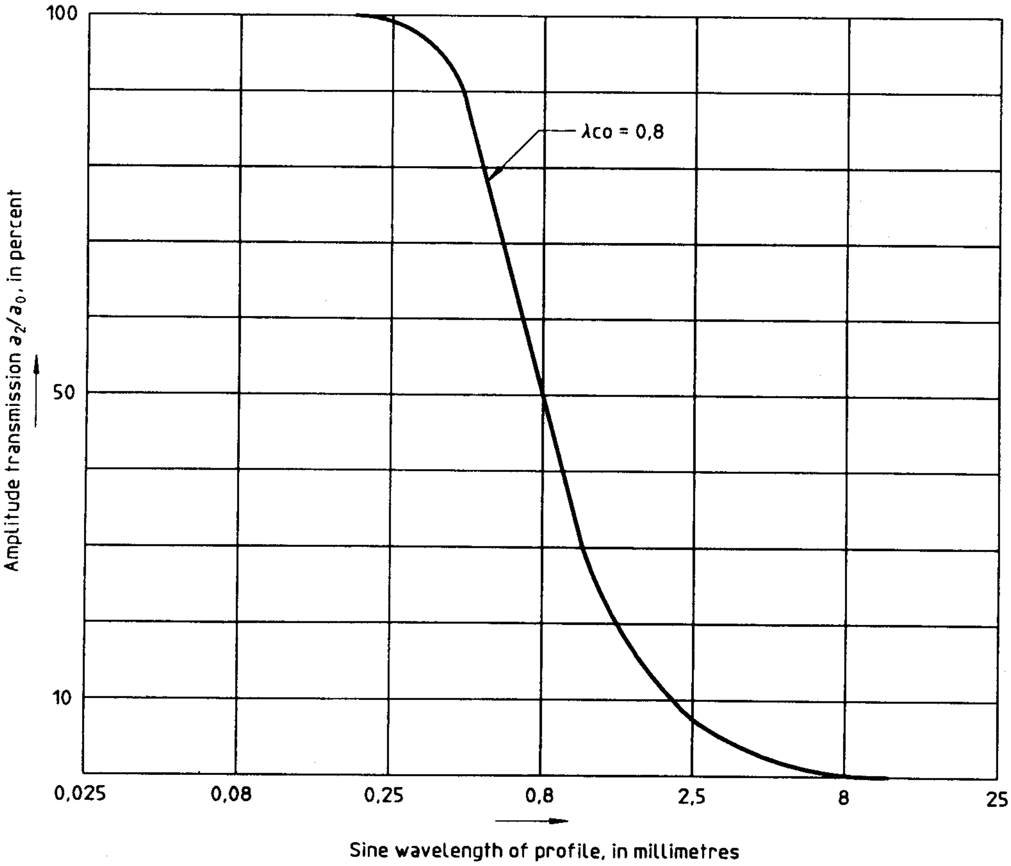


Figure 3 — Transmission characteristic for the short wave profile component

4 Limits of error of phase correct filters

For phase correct filters no tolerance values are given.

Instead of tolerances, a graphical representation of the deviations of the realized phase correct filter from the Gaussian filter shall be given as a percentage value over the wavelength range 0,01 λco to 100 λco. An example of a deviation curve is given in figure 4.

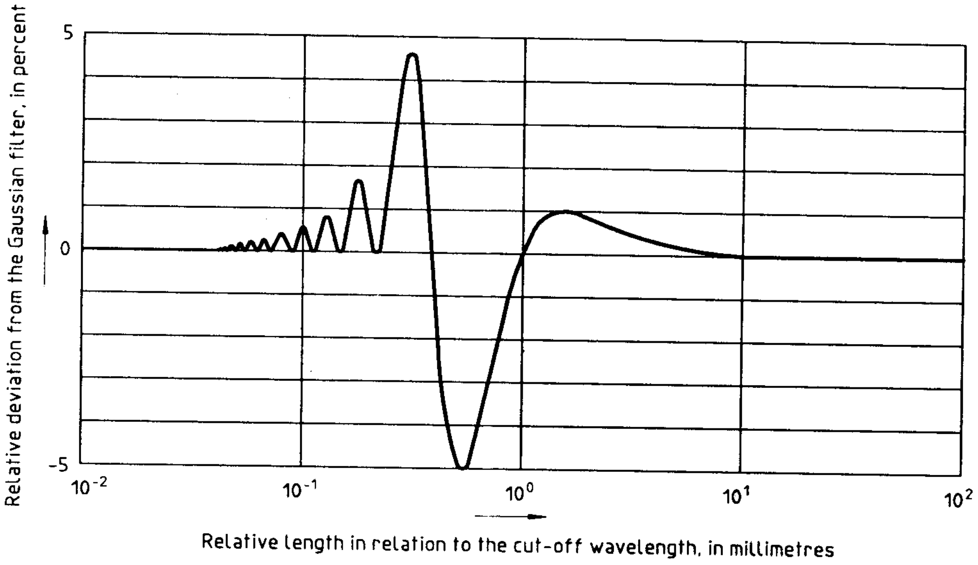


Figure 4 — Example of a deviation curve of a realized phase correct filter from the Gaussian filter

Annex A
(informative)

Criteria for selection of phase correct filters

The following criteria have been taken into consideration in the preparation of this International Standard.

a) Spatial and frequency characteristics are of equal importance. Previous discussion tended to ignore the effect of an oscillatory weighting function. This effect is becoming more and more important with the advent of multi-processes and has to be catered for in new instruments.

b) The filtered profile, even close to the cut-off, is no longer distorted due to phase shift, with the result that the short wave profile component emerging from the filter can look like the short wave component on the original profile.

c) Parameters such as profile bearing length ratio and peak height in the region of the cut-off become measurable with greater realism.

d) There is a complementary relationship between the transmission characteristics of short wave and long wave profile components. Therefore both the characteristics must have

- phase corrected properties;
- 50 % transmission at the cut-off.

e) In practice it is recognized that, for digital systems, the phase correct filter will be implemented by use of a Gaussian approximation.

f) If tolerances are given they have to be meaningful from the calibration point of view and from the point of view of the application. This was impossible by giving pure tolerance values. Therefore the instrument makers must provide a graphical representation of the realized filter as given in clause 4.

g) New filters have to be compatible with the existing 2RC filters defined in national and International Standards in order to get comparable results.

Annex B
(informative)

Relation to the GPS matrix model

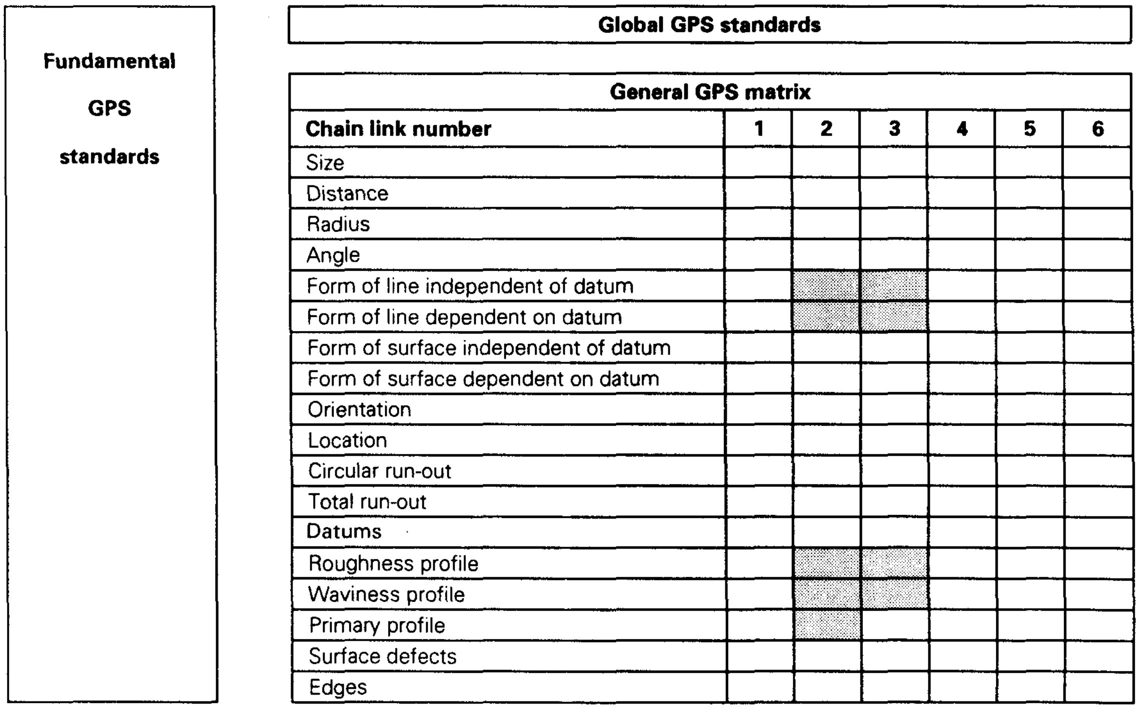
For full details about the GPS matrix model, see ISO/TR 14638.

B.1 Information about this International Standard and its use

This International Standard specifies the metrological characteristics of phase correct filters for the measurement of surface profiles. It specifies in particular how to separate the long and short wave content of a surface profile.

B.2 Position in the GPS matrix model

This International Standard is a General GPS standard, which influences chain links 2 and 3 of the chains of standards for roughness profile and waviness profile and chain link 2 of the chain of standards for primary profile and is envisaged also to cover roundness and other form characteristics in the *General GPS matrix*, as graphically illustrated in figure B.1.



Fundamental GPS standards

Global GPS standards

General GPS matrix

Chain link number	**1**	**2**	**3**	**4**	**5**	**6**
Size						
Distance						
Radius						
Angle						
Form of line independent of datum		▨	▨			
Form of line dependent on datum		▨	▨			
Form of surface independent of datum						
Form of surface dependent on datum						
Orientation						
Location						
Circular run-out						
Total run-out						
Datums						
Roughness profile		▨	▨			
Waviness profile		▨	▨			
Primary profile		▨				
Surface defects						
Edges						

Figure B.1

B.3 Related standards

The related International Standards are those of the chains of standards indicated in figure B.1.

Annex C
(informative)

Bibliography

[1] ISO/TR 14638:1995, *Geometrical Product Specifications (GPS) — Masterplan.*

[2] *VIM — International vocabulary of basic and general terms in metrology.* BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 2nd edition, 1993.

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